

WHAT IS CLAIMED IS:

1 1. A method of separating CO<sub>2</sub> from a hydrocarbon gas inlet stream that is within  
2 predetermined pressure and temperature ranges, comprising the steps of:

3 (a) subjecting the inlet stream to fractional distillation providing a CO<sub>2</sub> bottom  
4 product stream and a distillation overhead stream;

5 (b) passing the distillation overhead stream to the inlet of a primary reflux drum  
6 producing a primary reflux liquid stream and a hydrocarbon vapor stream;

7 (c) subjecting the hydrocarbon vapor stream from step (b) to membrane  
8 separation to provide a hydrocarbon product stream and a permeate stream;

9 (d) compressing the permeate stream from step (c) to provide a compressed  
10 permeate stream; and

11 (e) recycling the compressed permeate stream from step (d) to said inlet of said  
12 primary reflux drum thereby providing a primary reflux liquid stream and a hydrocarbon  
13 gas product vapor stream.

1 2. A method of separating CO<sub>2</sub> from a hydrocarbon gas inlet stream according to claim 1  
2 including:

3 passing said CO<sub>2</sub> bottom product stream from step (a) to a reboiler separator that  
4 provides a reboiler separator vapor stream directed to a bottom portion of said distillation  
5 column and a reboiler separator liquid stream.

1 3. A method of separating CO<sub>2</sub> from a hydrocarbon gas inlet stream according to claim 2  
2 wherein said CO<sub>2</sub> bottom product stream from step (a) is pumped at increased pressure to  
3 said reboiler separator.

1 4. A method of separating CO<sub>2</sub> from a hydrocarbon gas inlet stream according to claim 1,  
2 including the step of passing at least a portion of said reboiler separator liquid stream  
3 through a pressure reduction device to reduce the pressure thereof and adding heat thereto  
4 to provide a CO<sub>2</sub> gas product.

1 5. A method of separating CO<sub>2</sub> from a hydrocarbon gas inlet stream that is within  
2 predetermined pressure and temperature ranges comprising the steps of:

3 (a) subjecting the inlet stream to fractional distillation in a distillation column  
4 providing a CO<sub>2</sub> bottom product stream and a distillation overhead stream;

5 (b) subjecting said distillation overhead stream of step (a) to membrane  
6 separation, providing a hydrocarbon gas product stream and a permeate stream;

7 (c) compressing said permeate stream to provide a compressed permeate stream;  
8 and

9 (d) refluxing said compressed permeate stream from step (c) back into said  
10 distillation column.

1 6. A method of separating CO<sub>2</sub> from a hydrocarbon gas inlet stream according to claim 5 in  
2 which step (d) is carried out by refluxing said compressed permeate stream from step (c)

3 through a primary reflux drum having a primary reflux liquid stream outlet in  
4 communication with said distillation column.

1 7. A method of separating CO<sub>2</sub> from a hydrocarbon gas inlet stream according to claim 5,  
2 including between steps (c) and (d) the additional step of passing said compressed  
3 permeate stream through a secondary reflux drum.

1 8. A method of separating CO<sub>2</sub> from a hydrocarbon gas inlet stream according to claim 5  
2 including:  
3       subjecting at least a portion of said CO<sub>2</sub> bottom product stream from step (a) to  
4 reduced pressure to provide a CO<sub>2</sub> gas product.

1 9. A method of separating CO<sub>2</sub> from a hydrocarbon gas inlet stream according to claim 8  
2 including the step of:  
3       passing a portion of said CO<sub>2</sub> bottom product stream through a pressure reduction  
4 device through at least one heat exchanger used to adjust the temperature range of said  
5 hydrocarbon inlet stream.

1 10. A method of separating CO<sub>2</sub> from a hydrocarbon gas inlet stream that is within  
2 predetermined pressure and temperature ranges, including the steps of:  
3       (a)     subjecting the inlet stream to a distillation column producing a bottom  
4 product stream and a distillation overhead stream;  
5       (b)     condensing said distillation overhead stream of step (a) in a primary reflux  
6 drum producing a primary reflux liquid stream and a hydrocarbon vapor stream;

7 (c) recycling said primary reflux liquid stream of step (b) to said distillation  
8 column as a reflux stream;

9 (d) separating said concentrated hydrocarbon vapor stream from step (b) by  
10 membrane separation into a hydrocarbon gas product stream and a permeate stream;

11 (e) compressing said permeate gas stream from step (d) to produce a  
12 compressed permeate stream;

13 (f) condensing said compressed permeate stream of step (e) to produce a  
14 primary reflux liquid stream that is conveyed to an upper portion of said distillation  
15 column;

16 (g) pumping said bottom product stream from step (a) to provide an elevated  
17 pressure liquid CO<sub>2</sub> product; and

18 (h) subjecting said bottom product stream of step (a) to a reboiler separator to  
19 produce a CO<sub>2</sub> liquid product and a reboiler separator vapor stream that is recycled to a  
20 bottom portion of said distillation column.

1 11. A system for separating CO<sub>2</sub> from a hydrocarbon gas inlet stream that is within  
2 predetermined pressure and temperature ranges, comprising:

3 a distillation column receiving the hydrocarbon gas inlet stream and providing a  
4 CO<sub>2</sub> bottom product stream and a distillation overhead stream;

5 a primary reflux drum having an inlet receiving the distillation overhead stream  
6 and producing a primary reflux liquid stream and a hydrocarbon vapor stream;

7 a membrane unit receiving the hydrocarbon vapor stream from said primary  
8 reflux drum to provide a hydrocarbon gas product stream and a permeate stream;

9 a compressor receiving said permeate stream from said membrane unit to provide  
10 a compressed permeate stream; and  
11 piping to recycle said compressed permeate stream to said inlet of said primary  
12 reflux drum thereby providing a liquefied CO<sub>2</sub> product and a hydrocarbon gas product.

1 12. A system of separating CO<sub>2</sub> from a hydrocarbon gas inlet stream according to claim 11  
2 including:

3 a reboiler separator having an inlet that receives said CO<sub>2</sub> bottom product stream  
4 from said distillation column and that provides a reboiler separator vapor stream to a  
5 bottom portion of said distillation column and a CO<sub>2</sub> liquid product.

1 13. A system for separating CO<sub>2</sub> from a hydrocarbon gas inlet stream according to claim 11  
2 including;

3 a CO<sub>2</sub> bottom product pump in line with said CO<sub>2</sub> bottom product stream to  
4 increase the pressure within said reboiler separator.

1 14. A system of separating CO<sub>2</sub> from a hydrocarbon gas inlet stream according to claim 11  
2 including a primary refrigerant pressure reduction device through which at least a portion  
3 of said CO<sub>2</sub> liquid product from said reboiler separator is passed to reduce the pressure  
4 thereof and add heat thereto to provide a CO<sub>2</sub> gas product.

1 15. A system for separating CO<sub>2</sub> from a hydrocarbon gas inlet stream that is within  
2 prescribed pressure and temperature ranges comprising:

3 a distillation column for receiving and fractionally distilling the hydrocarbon gas  
4 inlet stream providing a CO<sub>2</sub> liquid product and a distillation overhead stream;

5 a membrane unit receiving the distillation overhead stream and providing a  
6 hydrocarbon gas product and a permeate stream;

7 a compressor receiving the permeate stream and providing a compressed permeate  
8 stream; and

9 a primary reflux drum receiving said compressed permeate stream providing a  
10 primary reflux liquid stream that is refluxed back into said distillation column.

1 16. A system for separating CO<sub>2</sub> from a hydrocarbon stream according to claim 15 including  
2 a secondary reflux drum that receives said compressed permeate stream and that provides  
3 a secondary reflux liquid stream that is refluxed to said distillation column.

1 17. A system for separating CO<sub>2</sub> from a hydrocarbon stream according to claim 15 including  
2 a primary refrigerant pressure reduction device through which at least a portion of said  
3 CO<sub>2</sub> bottom product stream is passed to reduce the pressure thereof to provide a CO<sub>2</sub> gas  
4 product.

1 18. A system for separating CO<sub>2</sub> from a hydrocarbon inlet stream according to claim 17  
2 including an inlet cross heat exchanger through which said CO<sub>2</sub> gas product from said  
3 refrigerant pressure reduction device passes and through which the hydrocarbon inlet  
4 stream passes to thereby serve to adjust the temperature range of the hydrocarbon inlet  
5 stream.